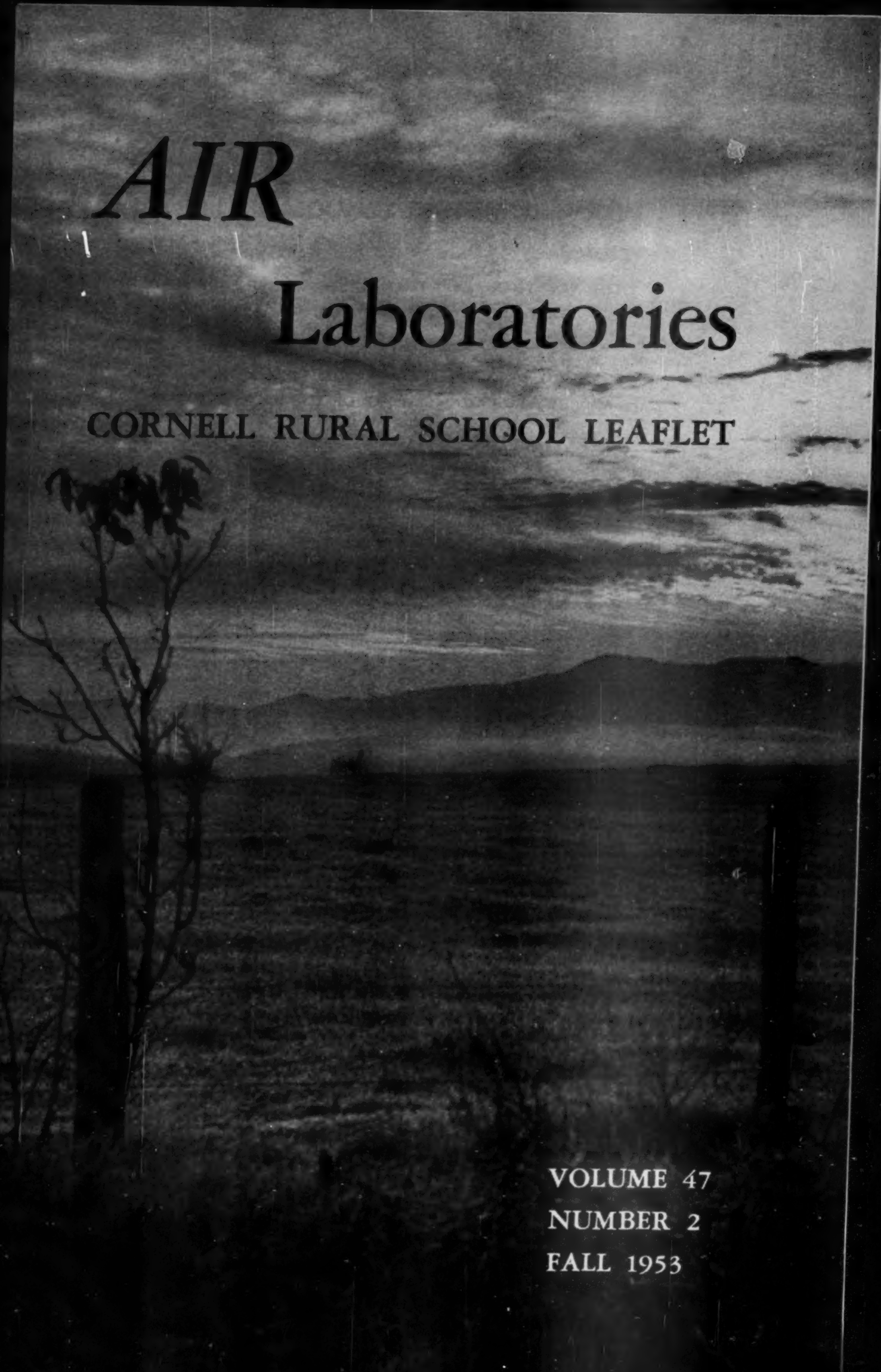

# AIR Laboratories

CORNELL RURAL SCHOOL LEAFLET

VOLUME 47
NUMBER 2
FALL 1953

# CORNELL RURAL SCHOOL LEAFLET

PUBLISHED BY
THE NEW YORK STATE COLLEGE OF AGRICULTURE AT
CORNELL UNIVERSITY, ITHACA, NEW YORK
W. I. MYERS, DEAN OF THE COLLEGE

THE DEPARTMENT OF RURAL EDUCATION
ANDREW LEON WINSOR, HEAD OF THE DEPARTMENT

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Illustrations are by Verne N. Rockcastle. The cover picture is of Mount Seward, in the Adirondacks. It shows frost in the foreground and fog in the valley at the foot of the mountain. The clouds are in two layers: the higher ones fully lighted by the rising sun; the lower clouds darker gray. The picture was taken in October, at 6:30 a.m. Within two hours both fog and frost had disappeared.


A publication of the
New York State College of Agriculture,
a unit of the State University of New York,
at Cornell University

Published by the New York State College of Agriculture at Cornell University, Ithaca, New York. L. R. Simons, Director of Extension. Published and distributed in furtherance of the purposes provided for in the Acts of Congress of May 8 and June 30, 1914.

# Air Laboratories

By VERNE N. ROCKCASTLE and EVA L. GORDON

Up to now the "laboratories" Leaflets have dealt with things you can see, such as water *(Wet Laboratories),* the sun, moon, and planets *(Sky Laboratories),* and trees and shrubs *(Wooded Laboratories).* This Leaflet deals with something you all know is present but no one can see: *air.* You can feel air move against you and you can see what it does, in the form of wind, to many objects. You can see it carry clouds across the sky, move sailboats on the water, and sway tall trees. Sometimes you hear it whistle about the eaves of the house or sweep through the screens on the porch. Men have always lived in air and have depended upon it for their very existence, but they still have much to learn about it. You can find and demonstrate many facts about air in your own *air laboratory.*

First, what is air really like? It doesn't have any taste or odor and you can't see it. It is a huge invisible sea of gases which moves all over the surface of the earth. This air-sea covers high mountains. It swishes around your feet and face and in and out of trees. It trickles into houses, barns, and garages, down into little holes in the ground and into cracks and crevices in rocks, wood, and windows. It leaks into jars of canned goods which aren't sealed tightly. It rushes in and out of your lungs when you breathe. It even dissolves in the water that stands in ponds and lakes or flows in streams. Can you think of *anywhere* on the earth that air cannot go?

This great air sea at the bottom of which you live is very deep – probably more than 200 miles. If you could stand at the bottom of a clear lake and look up when a stone was thrown into the water, you could perhaps tell where the surface of the lake was by the ripples which the stone made. We can't see ripples on the surface of our gigantic lake of air when something strikes it. But when a little particle of something speeds into our air from out in space, it begins to glow as it becomes heated by the terrific friction of the air. These glowing particles are called *meteors* or "shooting stars." They continue to glow or burn until they either

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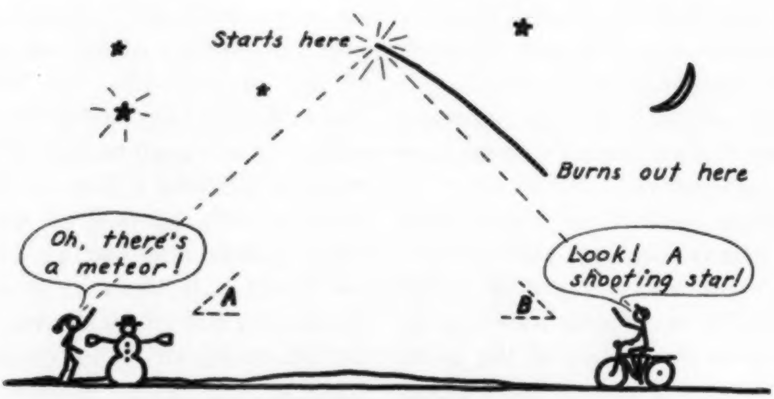
hit the ground as meteorites or burn out. Two persons standing several miles apart but watching the same meteor would see it in different positions. By geometry we can use what they see to tell where the glow began. Meteors start to glow from 200 to 500 miles above the earth's surface. Indeed, this *is* a deep air sea in which we live!

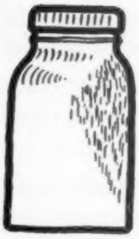
Many different gases all mixed together make up the air in this vast sea. About four-fifths of the air is *nitrogen* and almost all the rest is *oxygen*. Your textbook will tell you about other gases that are present in small quantities. We don't use the nitrogen directly, but it dilutes the oxygen which we do use. Nitrogen from the air is used by plants — not as pure nitrogen, but in a chemical form which some bacteria of the soil are able to make.

## Water in the Air

The air also contains some water in gaseous form, called *water vapor*. A simple experiment will show you a few characteristics of this gas. Your breath is air that contains much water vapor. Breathe once or twice into a warm, dry quart mason jar and immediately seal it tight. Can you see moisture on the inside of the jar? Now place the jar out-of-doors on a cold day or in a refrigerator next to the cooling unit. Leave it for about 15 minutes, then examine it again. Can you see that the inside of the jar is covered with tiny droplets of water? If your jar was in a refrigerator, is there more water on the side which was nearest the cooling unit or on the side which was farthest from it? Now place the sealed jar in a warm spot and




The higher the meteor the greater are A and B



*Is the fog near the coils or on the other side?*

wait. What happens to the water in the jar?

When air is warm, the water in it usually is in gaseous form — invisible. When air is cooled enough, some water vapor *condenses* into droplets and becomes visible. What would happen if we could cool the jar even more than the refrigerator cools it? You might put a sealed jar of air outdoors on a very cold day and see. If you have a freezer in your school or home, you can put a sealed jar of air into the freezer and see what happens.

Warm air can hold more water vapor than cold air can. A quart of very cold winter air may hold only a tiny quantity of water vapor. A quart of warm summer air may hold many times as much. You might try the refrigerator experiment at home, using a quart of air from the bathroom when someone is taking a shower or hot bath. Then take a quart of air from the living room or a quart of air from outside the house. Which of these samples "fogs up" more in the refrigerator? Which sample has more water vapor in it?

Air that has all the water vapor it can hold is *saturated*. When this happens, usually the weather is foggy, or rainy, or snow is falling. If no moisture condenses, probably the air is not saturated. If the air in your classroom is holding only one-half of what it *could* hold at its temperature, it is only half-way saturated with water vapor. This closeness to saturation is called *relative humidity* and is expressed as a percentage:

| | |
|---|---|
| No water vapor present — | 0% relative humidity |
| Half-way saturated — | 50% relative humidity |
| Saturated with water vapor — | 100% relative humidity |

For comfortable living, the relative humidity of a classroom or home should be somewhere between 40 per cent and 60 per cent. At humidities much higher than this, you begin to feel clammy and the air seems "muggy"

**Summer Air**

**Winter Air**

*Warm summer air holds more water vapor than cold winter air!*

as it does on some summer days. At humidities much lower than this, the air feels cold even though its temperature has not decreased. The feeling of coolness is caused by the rapid evaporation of moisture from your body. That evaporation cools your skin.

The relative humidity of the air can be measured by an instrument called a *hygrometer*. In one type of hygrometer, human hair is used to move a pointer. The hair changes its length as the relative humidity changes. Perhaps you can make a simple hair hygrometer. First wash several 12-inch strands of hair in alcohol to remove any oil or grease. Then glue one end of the hairs to a needle, rolling the hairs on the needle as shown in the diagram. Mount the needle in cardboard so that it will turn when the hairs are pulled. Fasten the other end of the hairs to a board as shown. Attach a pointer to the end of the needle so that the weight of the pointer will keep the hair tight. Fix a scale so you can tell how much the pointer moves up or down. The pointer on your hygrometer moves because the hairs change in length.

You can use your hygrometer to tell which way the relative humidity changes — whether it becomes higher or lower. Does your hygrometer show any difference in relative humidity between the living room of your house and the bathroom or the kitchen? See whether the relative humidity of your classroom changes from day to day. Is the relative humidity of your classroom higher or lower than it is outside? Does the relative humidity differ when your classroom is warm and when it is cool? Does the hair get longer or shorter as the relative humidity increases? Does the hair change


Hair Hygrometer

in length as the temperature changes? Perhaps you can find other things which will work as well as human hair.

### Measuring Temperature

It is easy to feel and to measure air temperatures. The way the air feels to us, though, is not always a good indication of its temperature. Our bodies are sensitive to temperature changes but do not make very good thermometers. A simple experiment will show why.

Go around the room and place your hand on different objects. Label each object with a paper slip, showing how the object feels to you. Is it *cold, cool, warm,* or *hot?* Does an object made of iron feel cooler or warmer than one made of wood? Does wood feel cooler or warmer than cloth? How does this Leaflet feel compared with the top of your desk? Now lay a thermometer, bulb down, on the first object you touched. Leave it until the temperature stops changing. Then write the temperature of the object on the paper label. Do the same for each object you felt and labelled. How does the temperature of this Leaflet compare with that of your desk top? Is the iron object really colder than this Leaflet? How much? Do *you* think your hand is a very good thermometer?

This Leaflet is not a good *conductor* of heat. It does not take heat away from your hand rapidly. The iron is a good conductor of heat and takes heat away from your hand very quickly. An object feels colder to you if your hand is losing heat rapidly than it does if your hand is losing no heat or losing heat slowly. How would the object feel if your hand is gaining heat? This helps to explain why your body is a better indicator of heat change than it is of temperature.

To see what happens to air as its temperature rises, put some water into a small dish and then hold a small-mouthed bottle upside down so that the mouth is just under water. As your hands warm the bottle and the air in it, what happens at the mouth of

**An Air Thermometer**

the bottle? What happens to the air inside the bottle as it gets warmer? Now place a wet handkerchief around the bottle and blow on it or fan it. What happens at the mouth of the bottle? Is the bottle warmer or cooler than it was when you had your hands around it? This *expansion* and *contraction* of the gases that make up air can be used to indicate temperature, just as does the expansion and contraction of mercury in many thermometers.

Most things expand when they are heated and contract when they are cooled. Gases expand or contract the most, liquids next, and solids the least. In mercurial thermometers a little change in the volume of the mercury in the bulb causes a big change in the tiny tube. If the expansion and contraction of the air in a bottle shows in a small tube, a small change looks like a big change.

You can make a very simple air thermometer by arranging a bottle, a transparent soda straw or a glass tube, and a cork as shown in the diagram on page 7. Tie the bottle with string to an upright stick or fasten it with scotch tape or rubber bands. Heat the bottle by wrapping a hot cloth around it or by placing it in a warm oven for a few minutes. Then at once place the end of the tube in some colored water or ink. Watch the liquid move up the tube as the air in the bottle cools and contracts.

You can mark a scale on your thermometer by comparing it with a "store" thermometer first in a warm place and then in a cold place. At school in winter the outdoors might be the cold place, and near the radiator indoors the warm place. At home the refrigerator and a barely warm oven might serve. Make marks on your scale for both the warm and the cold positions of the colored liquid in the tube and write the temperatures which the "store" thermometer shows. Which is higher on your tube, the "cold position" or the "warm position?" You really have an upside-down thermometer with the bulb (filled with air) at the top.

You can now divide the space between your warm and cold marks into smaller equal spaces. How many degrees does each space on the "store" thermometer represent? Can you divide the space between your warm mark and your cold mark so that there will be 2 degrees in each small space? If the space between your warm and cold marks is too short to divide into 2-degree spaces, you can use 4-degree spaces, or even 5-degree spaces. Most thermometers have 2-degree marks. Your thermometer will be quite

accurate if you construct it carefully, but it will not change very rapidly with quick temperature changes. Why?

The thermometer you made works in general as do most thermometers, but it has some limitations that "store" thermometers do not have. What would happen if you put your home-made thermometer out in the snow to measure the temperature when the temperature was several degrees below freezing? What could you do to prevent this? Can you use anything else in your thermometer tube besides colored water or ink? Thermometers that have silver-colored liquid in them usually contain mercury and are called *mercurial thermometers.* Those that have red indicators in them may contain colored alcohol. Why is it better to use alcohol in thermometers than to use water? Why do some persons put alcohol in their car radiators in winter?

Perhaps you can find at home or at school other thermometers that are not like the ones described in this Leaflet. Do all of them depend upon something which *expands* as it gets warm and *contracts* as it gets cold?

**Wind**

Think of things you have seen the wind do. It rustles the leaves of the trees, makes the school flag wave back and forth, blows the snow into drifts, drives a sailboat over the water, or even makes noises around the eaves of the house or in the telephone wires. What we call wind is simply *air in motion.* When things are in the way of moving air, it pushes against them; sometimes it pushes with enough force to move them or to blow them over.

Hold a piece of cardboard in front of you when you face the wind. The top or bottom of a suit box will do. Can you feel the card push against you? Does it push with the same steady force all the time or does the push feel unsteady? Now find a level spot where you won't fall and get hurt. Run into the wind, holding the cardboard in front of you. Turn around, hold the cardboard against your back and run with the wind blowing against your back. Put the cardboard down and again run into the wind and then with the wind. How much difference did the cardboard make?

Face the wind and hold a piece of cardboard level (parallel with the ground) in front of you. Now slant the cardboard so that any object placed on it would slide away from you. Which way does the wind seem to push the cardboard? Tip the cardboard so that it would slide objects toward you.

Does the wind push the card down or up? Can you slant the cardboard so that the wind seems to lift it into the air? Although this is not exactly the way an airplane wing works, it is one way in which the air can be made to lift things such as kites and birds.

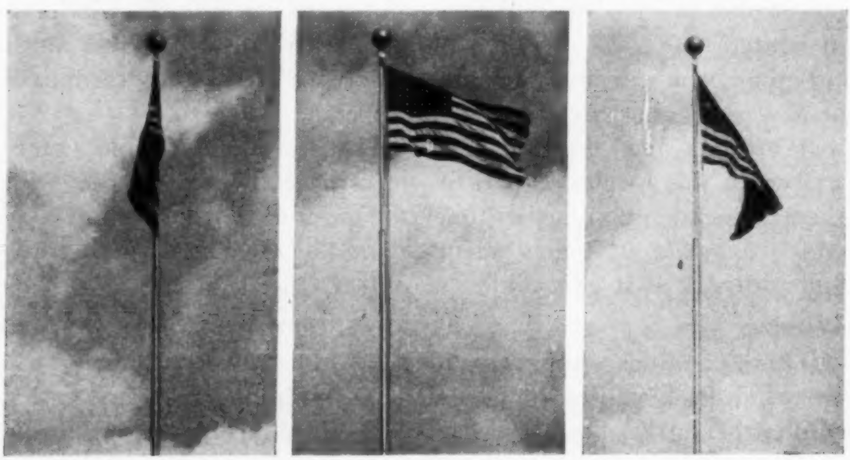
## Wind Velocity

The speed with which the air moves often determines what sort of weather we may expect and whether frost, dew, or fog will form. With a little practice you can tell about how fast the wind is blowing by watching the leaves of the trees, the school flag, or the smoke of a nearby chimney.

Wind velocity is usually expressed in miles per hour (mph). How wind of different speeds affects a school flag is shown below.

Wind velocity is often expressed as a *Beaufort number* according to a scale originated by Admiral Sir Francis Beaufort of the British Navy in 1805. Admiral Beaufort's scale of wind velocities used numbers from 0 to 12 to indicate wind speed from calm to hurricane. It was first planned to help sailors manage their ships but it was later changed so that it could be used on land. It is now the standard scale the world over. The Beaufort Scale is given on page 11.

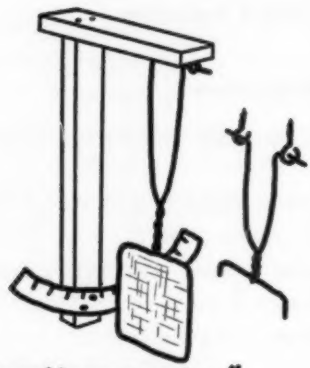
| | |
|---|---|
| Flag hangs limp | Wind less than 4 mph. |
| Flag flaps occasionally | Wind 4 to 7 mph. |
| Flag waves | Wind 8 to 12 mph. |
| Flag stands out from pole | Wind 13 to 18 mph. |
| Flag pulls rope with it | Wind 19 to 24 mph. |
| Flag snaps as it flaps | Wind 25 to 31 mph. |
| Better take it in! | Wind more than 31 mph. |



**The Beaufort Scale of Wind Velocities**

| Beaufort number | Symbol | Miles per hour | Description |
|---|---|---|---|
| 0 |  | 0 | Smoke goes straight up, calm |
| 1 |  | 1 to 3 | Smoke drifts; aspen leaves begin to tremble |
| 2 |  | 4 to 7 | Most leaves tremble; anemometer cups will move |
| 3 |  | 8 to 12 | Flag waves slowly |
| 4 |  | 13 to 18 | Flag flaps, tree branches move; good for kites |
| 5 |  | 19 to 24 | Leaves blow over ground; flag stands straight out |
| 6 |  | 25 to 31 | Wind begins to whistle around house; limbs sway; kites blow away |
| 7 |  | 32 to 38 | Can't hold umbrella open; twigs begin to break off |
| 8 |  | 39 to 46 | Difficult walking; whole trees sway |
| 9 |  | 47 to 54 | Large twigs break; very hard to walk; a few limbs break |
| 10 |  | 55 to 63 | Tree limbs break off |
| 11 |  | 64 to 75 | Trees uprooted; some roofs blow off |
| 12 |  | over 75 | Hurricane |

Sometimes we need to know the wind velocity more accurately than a flag or a Beaufort number will show it. Then we may use an *anemometer,* an instrument that measures wind velocity. Two types of anemometers are common : the pressure-plate and the rotating cup. A pressure-plate anemometer is a piece of thin metal against which the wind blows. The harder the wind blows, the harder it presses against the plate and the more pressure the plate puts on an electrical recording device. The commercial pressure-plate anemometers are complicated, but you can make a very simple one. Just hang a light-weight fly-swatter so that the wind can blow against it and push it away from the ver-

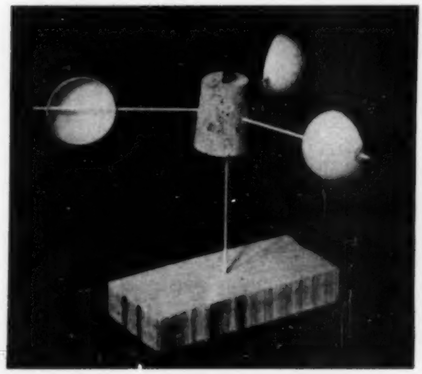


A "swattermometer"

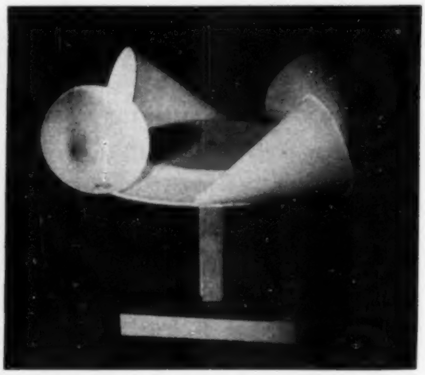
tical. The harder the wind blows the farther the fly-swatter gets pushed. Mount a scale next to the handle of the fly-swatter and mark the wind velocity on this scale. Perhaps the Beaufort Scale on page 11 will help.

You can make a scale for the fly-swatter anemometer by holding it out of a car window as someone drives you along a road on a calm day. While the car is going 10 miles an hour, make a mark on the scale where the handle of the fly-swatter hangs. This is the 10-mile-per-hour mark. Whenever the wind blows the fly-swatter to this mark, it has a velocity of about 10 miles an hour. In the same way you can mark your scale to show 20, 30, or 40 miles an hour.

A rotating cup anemometer can be easily made as follows: Through a 1-inch cork, drill a hole just large enough to receive one-half of a medicine capsule. Push the capsule-half, round end first, more than half-way through the hole in the cork. Now attach three paper cups or three halves of ping-pong balls to sucker, or lollipop, sticks and insert the sticks in the cork as shown. The cork can now be set upon the tip of a thin sharpened stick or of a long nail driven through a small board. The point of the nail should be filed sharp to reduce



**Ping-pong Ball Anemometer**



**Paper-cup Paper-plate Anemometer**

friction. The capsule acts as a bearing for the anemometer.

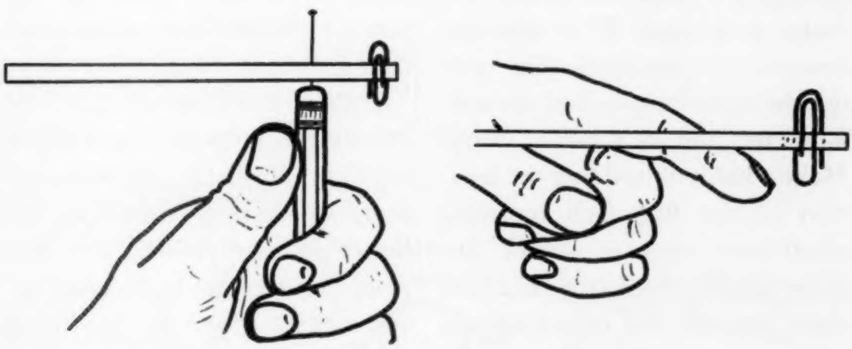
What happens to this anemometer as the wind blows? Can you count how many times a minute the cups revolve in what your swattermometer or your flag indicates as a 10-mile-an-hour wind? Paint one cup black and try again. Is it easier to count the number of revolutions per minute which a 10-, a 20-, or a 30-mile-per-hour wind causes. Which of the two anemometers is the more accurate? Why?

When you have used your anemometer at school for a few days, try it at home. Is the wind velocity the same in front of and behind your house? Does it differ near trees and in the open? Measure the wind velocity at noon and at supper time for a few days and keep a record. When is the wind velocity usually higher – during the middle of the day or in the evening?

## Wind Direction

An anemometer tells the speed of the wind, but not its direction. For that you can use a *weather vane*. You can make a simple weather vane from a pencil with an eraser, a pin, a soda straw, and a paper clip. Attach the paper clip to one end of the soda straw and balance the straw on your finger. Put a pin through the straw at the balancing point and pin the straw to the eraser of your pencil. You now have a weather vane. If you hold the pencil upright and blow toward the weather vane it will move so that it is parallel to the breeze. Which end is toward you?

You will have to know where north, east, south, and west are when you use your weather vane. Winds, you know, are named from the direction *from* which they blow. If you haven't a compass, can you tell from the direction of your shadow where north



**A Soda-straw Wind Vane**

**You might call this weather vane a feather vane**

is? How can you tell at night?

You can make a weather vane from a feather, weighting one end of it with a paper clip or a piece of wire, and attaching it to a pencil eraser with a pin. If you make the pinhole in the feather with a thick pin and attach it to the pencil with a thinner pin, it will turn freely. Is this weather vane more or less sensitive than the soda straw? Perhaps you will want to make a more elaborate weather vane to set up on a broomstick in your yard. Some of the books listed on page 32 will show you how to make different kinds of weather vanes. Watch for weather vanes on houses and barns. What different designs can you find? Can you use the school flag as both an anemometer and a weather vane? Make a habit of noticing the position of the flag each morning when you come to school. Do some positions usually indicate clear weather and others cloudy or stormy weather? Which ones?

## Visibility

Have you ever noticed how much farther you can see on some days than on others? The clearness of the air is called its *visibility*. The visibility is high on some days and low on others. In some Western States on clear days a person can see 75 miles or even farther. In New York State it is often impossible to see more than 20 miles because the air contains fog, smoke, haze, or a combination of all three of these. Rain, fog, and snow sometimes reduce visibility to only a few feet.

Fog, rain, and snow are caused by condensation of water vapor. There is fog when water droplets are so tiny that you cannot see them as separate water drops. In a heavy rain there is much more water in the air than in heavy fog or in a heavy snowstorm. In which can you see better? Can you see better in a light rain or in a light fog? Probably you will decide that snow and fog cut down visibility even more than do raindrops.

Drivers traveling through fog often turn on special lights called *fog lights*. Probably you have seen some of these yellow-colored lights on cars. Where are they placed on the car? In the diagram you can see where the headlights and the fog lights point. Which

of the three light beams must go farthest before it strikes the road? Which beam travels the shortest distance? If the fog lights were mounted as high as the headlights, do you think they would help as much as they do when mounted close to the road? Many drivers think that fog lights shine well through fog because of the colored glass, but it is the closeness of the lights to the road that really makes them good fog lights. They would shine even farther if clear glass were used instead of yellow glass. Yellow light is probably easier on both your eyes and those of an approaching driver.

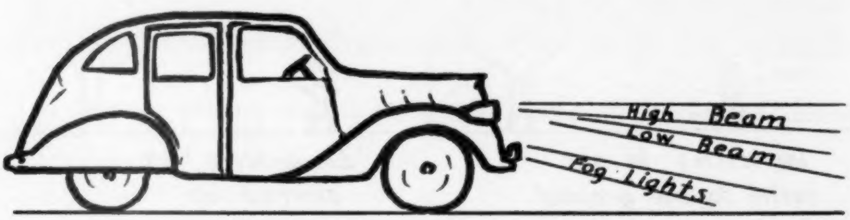
Airport beacons must shine as far as possible to tell approaching pilots where the airport is. Because these beacons must frequently shine through fog, rain, snow, smoke, or haze, they must use a very sharp beam. The next time you see an airport beacon (not a hilltop beacon — they are for another purpose) notice whether the glass is yellow like fog lights or is some other color.

Smoke and haze are impurities in the air. Usually they do not reduce visibility so much as does fog, rain, or snow. Often they give sunsets and sunrises the red color we like so much.

At night smoke frequently collects in layers in valleys or in low spots in fields. It may make visi bility very low during that time.

A mixture of smoke and fog is called *smog*. Thick smog may contain materials that make it dangerous to breathe. In New York State we have few industries that produce large quantities of smoke, but in some States the smog has occasionally been bad enough to contribute to a few deaths.

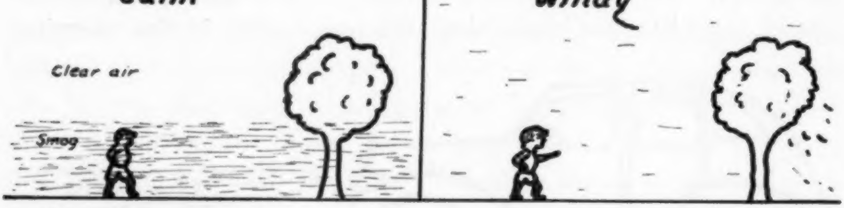
The visibility in a horizontal direction is frequently less than it is straight up because smoke, haze, or fog often lie in layers close to the ground. This often happens at night or early in the morning when the air is calm. Fog or smog layers may be only a few feet thick or as much as 100 feet or more. When they form during the night, they are often in thin layers and usually disappear early in the morning.



By eight or nine o'clock they have completely vanished. The photographs on page 17 are of a low field near Brockport, New York. The first picture was taken at 6:30 on an October morning while the fog and smoke were still present. The second was taken a half-hour later, and the third one hour later when the smog had disappeared. The smog layer was about 50 feet thick. In it the visibility was only about 200 feet. The air above it was clear, with a visibility of more than 2 miles. A person standing on the ground and looking straight up would look through only about 50 feet of smog. Looking straight ahead he would peer into smog that extended horizontally for nearly a half-mile. Can you see how it would be possible to see stars clearly through a thin layer of fog, while you could not see a road well enough to drive a car easily? Watch for patches of fog or smoke or smog near your school or your home early in the morning. Perhaps you can see some from the schoolbus window on your way to school.

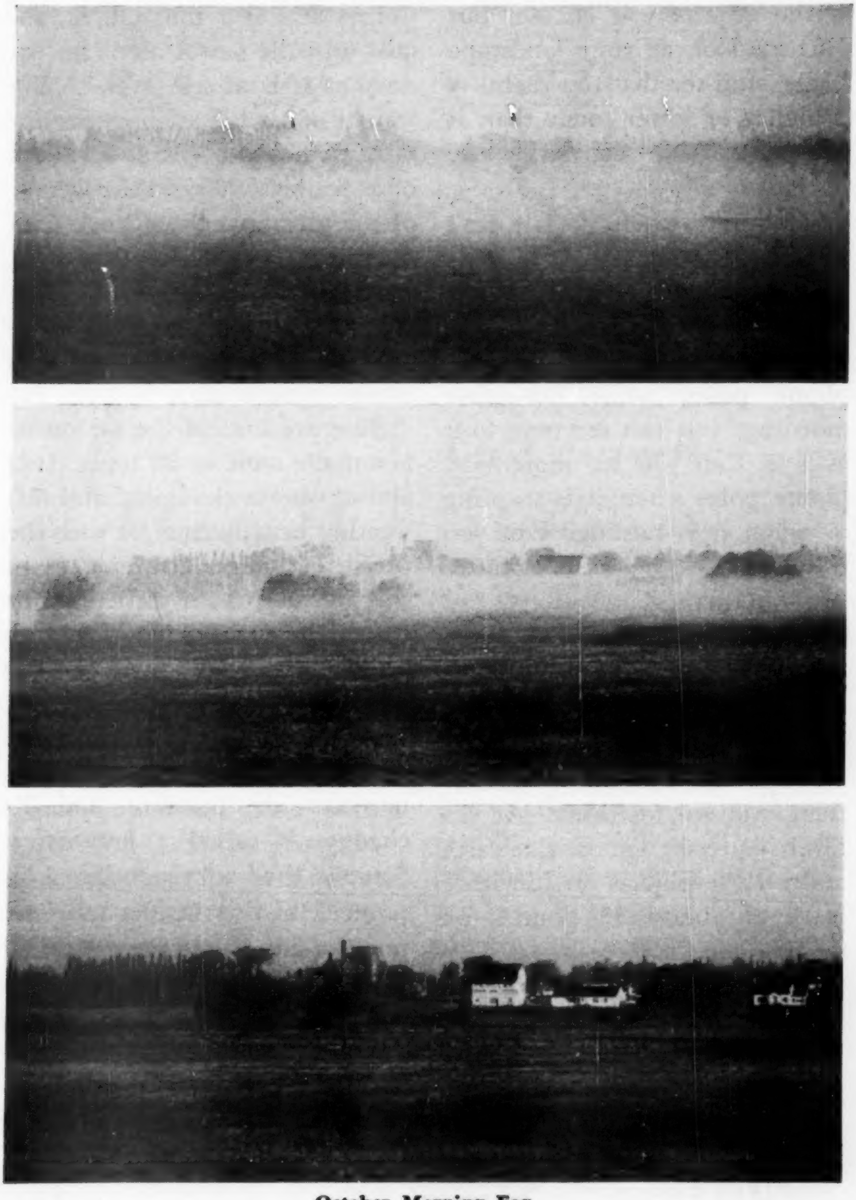
Wind stirs up smoke, fog, or haze and spreads it through the air. The impurities in the air do not remain near the ground. So when the wind blows, the horizontal visibility increases but the vertical visibility decreases. Can you see farther ahead on days when the wind is strong than you can when the wind is light or it is calm?

You may want to make a visibility scale to help you know how far you can see. The best way to make it is to pick out some objects on the horizon and use them for your scale. Perhaps you can use a nearby object, such as a telephone pole or a tree trunk; then a silo or a tree a little farther away; a building still farther from you, and so on. Your scale need not show the exact distances




*Impurities in air settle to the ground*

*Impurities all stirred up*



**October Morning Fog**

**At 6:30 *(top)* thick fog was evident; at 7:00 *(middle)* fog had thinned; at 7:30 *(bottom)* the air was clear.**

to the objects you choose, but you can look at your landscape "scale" and see that the visibility is higher or lower today than it was yesterday or the day before yesterday.

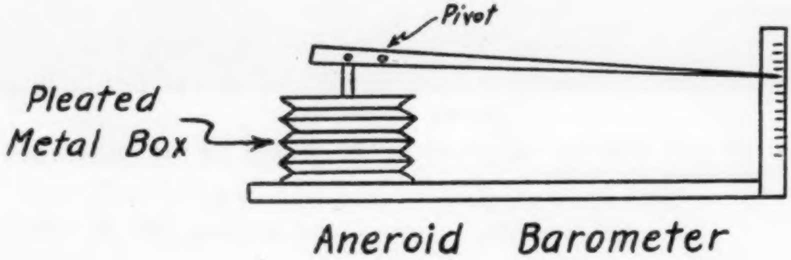
Sometimes when the air isn't very clear, your visibility scale can be one of several telephone poles. Maybe some mornings at seven o'clock you can see ten telephone poles, while on other mornings you can see only four or five. Can you see more telephone poles when it is snowing or when it is raining? Can you think of any other ways to measure visibility?

### Air Pressure

The tremendous sea of air in which we live presses on us from all directions with a force greater than you might think. At sea level it presses against the earth and all the objects on it with a force of almost 15 pounds on every square inch of surface. This means that a column of air a foot square and as deep as our air sea weighs almost 1 ton! On mountain tops the sea of air is not so deep as it is at sea level, so the weight of air is less above mountains than it is above low valleys or at sea level. Would the weight of the air above New York City be greater or less than that at your school? How would it compare with the weight of air above Mount Marcy, New York State's tallest mountain?

The pressure of the air on us is not the same at all times. It is almost always changing, and our weather usually changes with the pressure changes. Differences in the pressure of the air cause our winds. Pressure changes are often a great help in telling what the weather is going to be in the next few hours.

The instrument that is used to measure air pressure and its changes is called a *barometer*. Some of the books mentioned on page 32 of this Leaflet tell how to make simple barometers. Often these are not accurate, but you can learn much from making and

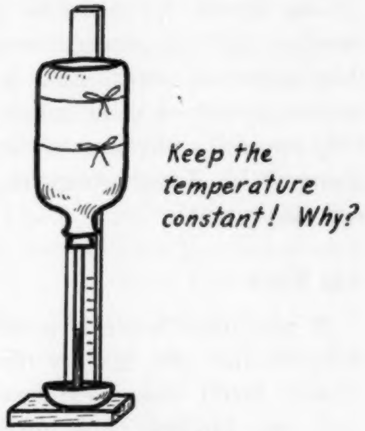



Aneroid Barometer

using one. For accurate studies, a factory-made barometer is usually better and there is one in many schools.

Barometers are generally of two types; *aneroid* and *mercurial*. The aneroid barometer contains no liquid, but is simply an accordion-like metal box from which part of the air inside has been removed. As the air pressure on the outside of the box increases, it pushes the top and the bottom of the box closer together. This causes a pointer to move across a scale as shown in the diagram on page 18. Which way does the pointer move if the air pressure becomes less?

A mercurial barometer is made of a glass tube closed at one end and filled with mercury. This tube is then turned upside down with the open end closed with a finger until it can be placed in a dish of mercury. Air pressure will hold the mercury in the tube about 29 or 30 inches higher than the mercury in the dish. When the air pressure increases, the mercury rises in the tube. When the air pressure decreases, the mercury level in the tube is lower. Perhaps you can make a mercurial barometer at your school; or you can ask the science teacher to make one for you to see. Most science rooms at central schools have a bottle of mercury




Liquid Barometer

and a glass tube. If you are permitted to make one yourself, be very careful not to spill the mercury. It is quite expensive and not always easy to replace.

You can make a simple barometer just as you made the thermometer illustrated on page 7. But to take accurate air pressure readings you will have to keep your barometer at the same temperature all the time. Why can't you take air pressure readings at just any temperature with this kind of barometer? If you can insulate the bottle you use so that temperature changes around it do not affect it very much, you will have a better barometer than one that isn't insulated. You could use an old thermos bottle in place of a plain bottle. Why might the thermos bottle make a better barometer?

Your barometer can show you whether the air pressure is getting higher or lower. That is an important bit of information to help you tell what the weather is going to be. Exact pressures are not important.

### Air Flow

If you have made a sensitive feather-vane, you can try this at home: Hold your feather-vane near the kitchen floor about 2 feet in front of the refrigerator door. Try to avoid drafts so that the feather stands still. Open the refrigerator door slowly so as not to fan the air near the vane. What happens to the vane when the door is open? Which way does the air move across the floor? Can you feel the cool breeze on your feet or hands? Such a breeze is called a *draft*. This one is a cold draft, but a draft may be of any temperature.

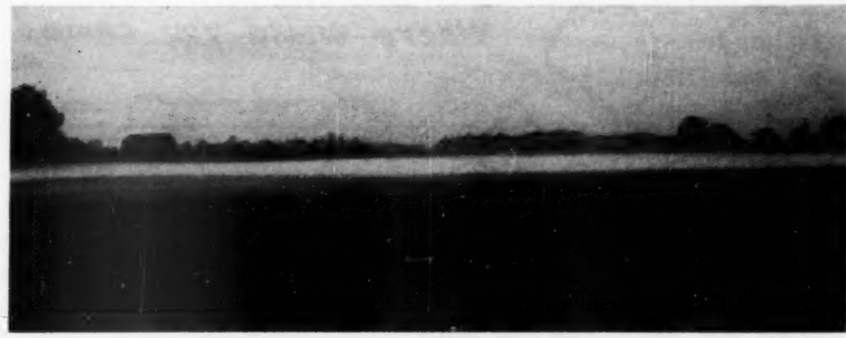
Leave the refrigerator door open and lift the feather-vane so that it is near the top of the refrigerator opening. Which way does the vane point? Is the air here moving into or out of the refrigerator? Can you find other places around your home where the vane shows drafts? Try it under some windows. Does the air below a window move toward the window or away from it? Perhaps you can indicate with small chalk marks or pieces of string which way the air moves in different parts of your home.

At school you can use windows on a cold day just as you used the refrigerator. You don't have to open the windows to get a "draft." Hold your feather-vane near the bottom of a cold window to see whether there isn't a draft even when the windows are closed. The air near the windows loses its heat. As it becomes cold-

**The straight top of the fog bank stretches from the trees at the right to the base of the mountain at the left.**

er than the air farther from the windows, it sinks to the floor.

Cold air may move over the land much as the cold air did from the refrigerator or near the cold windows. At night the ground loses heat by *radiation* — just as a hot, electric flat-iron cools when it is disconnected. As the ground cools, the air near it cools too. When the air next to the ground becomes cold and heavy, it moves downhill just as the cold air flowed downhill out of the refrigerator. It moves like a very slow stream of water, flowing around stones, down into little depressions, gathering in the hollows until they're filled, and then flowing downhill again. It trickles down the ditches beside the road, along the creek and river valleys, and finally comes to rest in the lowest places it finds. These are usually the swamps and river bottoms, the valleys and low basins so common throughout New York State. If the air in these "basins" or "fog pockets" cools enough, there may be condensation. Fog may form, first as a sort of misty or smoky layer. Finally the whole basin becomes fog-filled. The picture on this page shows such a fog pocket near Williamson, New York. You can see the fog as it began to form in layers. Within an hour the fog was about 10 feet deep and so thick that horizontal visibility was only about 50 feet. Above the cold air layer next to the ground, warmer, drier air is usually found. A person standing on higher ground can often see the level top of the fog in such pockets, with hills or buildings projecting above it. The white streak across the middle of the picture on page 20 is the top of a fog bank which formed over Tupper Lake, New York, in October. Above the fog the air was clear and visibility was more than 20

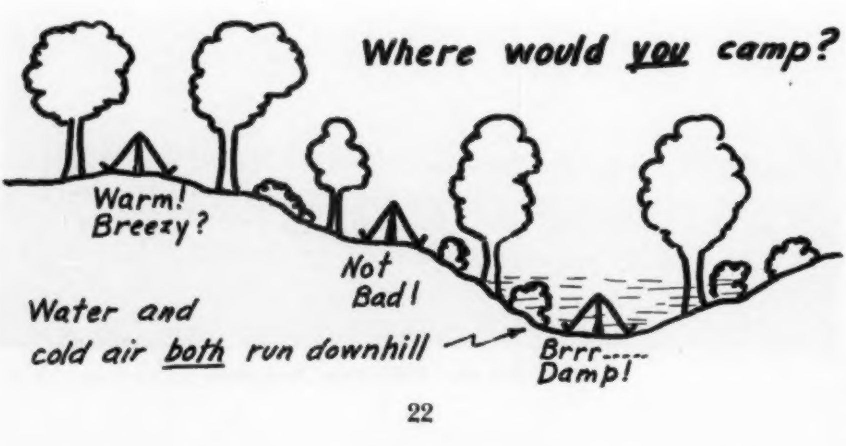


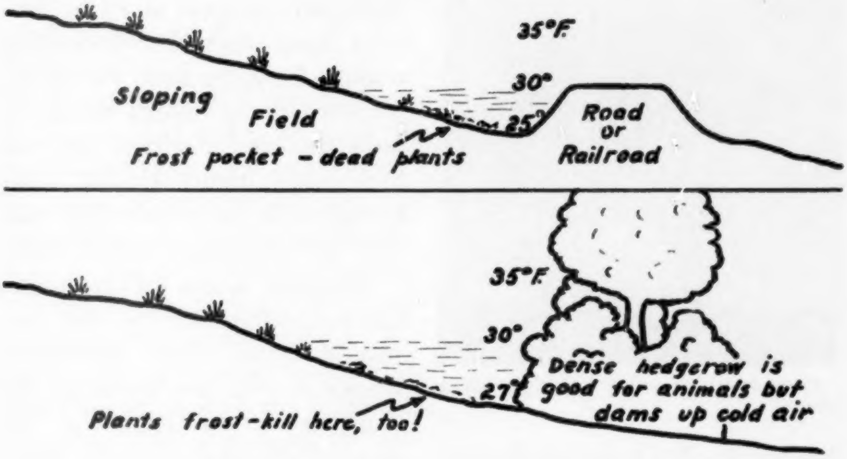
**A Fog Pocket near Williamson, New York**

miles. Just a few feet below the top of the fog the visibility was less than 200 feet. Can you find any such fog pockets near your school or home? When does the fog usually form in them? When does it disappear?

A few thermometers placed around your yard or schoolground will show you much about temperatures. Put one thermometer on a low hilltop, another in a low spot, and still another on a level surface. Then see for yourself the differences in the temperatures in each of these places. Read the temperatures in the morning before school starts (before breakfast is even better). Read them again during the lunch hour. What are the changes in temperature in these spots during the day? Which thermometer shows the lowest reading at breakfast time? Which shows the lowest reading at noon? You may have to read the thermometers for several days to get good answers to these questions. Does the wind velocity make any difference in the readings? Are the temperatures in the depression affected as much by wind as those on the hilltop or on the level?

If you are camping in late summer or early autumn your knowledge of cold air drainage will help you locate a warm campsite for sleeping. Which one of three equally attractive campsites would you choose if you do not want to be cold at night: a hilltop, a hillside, or a "basin"? Why? Would the stronger breeze on the hilltop help to keep mosquitoes away besides helping to keep the temperature from dropping? You can find out about differences in the temperature at three such campsites by placing a thermometer near the ground at each site. How does the temperature of the "basin" compare with that of the hilltop?






## Frost Pockets

Frost as well as fog may form in depressions when no frost shows in higher places. Frost forms when cold air in depressions cools so much that condensation occurs below the freezing point (32°F.) Temperatures on the ground may be several degrees lower than those a few feet above the ground, so frost may form on the grass when the temperature at eye-level is as high as 38°F. Of course, the ice crystals which make up the frost cannot form at 38°F., but at the level where they do form the temperature is *at or below freezing!* On mornings when you see no frost in low places, can you find any places around your school or home where frost has formed on the hilltops? What is likely to happen to the plants which grow in the frost pockets as compared with the plants which grow higher up on the hillsides? Perhaps you can find some low places near your school or home where some plants show early in the fall the wilting which is produced by frost. This is often called *frost-kill.*

## Local Effects of Wind

When a "weatherman" forecasts the weather, he often tells about "highs" and "lows" or storm areas and when and how they are expected to move across our State. The wind plays a large part in producing the "weather" that goes with these big air movements. Wind also produces many small effects that you can see and study in your own schoolyard or at home. The way the wind blows sometimes causes trees to grow in

**From which direction is the prevailing wind?**

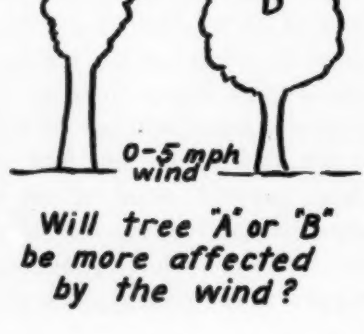
odd shapes. It causes uneven distribution of seeds. It makes leaves pile up in some places and sweeps other places clean. It makes snow drift and does other things you can see for yourselves.

When the wind blows more often from one direction than from any other, that direction is called the *prevailing wind direction.* In most of New York State the prevailing wind is from the north-west in winter and from the west or southwest in summer, so the wind is from westerly directions most of the time. Where the prevailing winds are westerly, trees sometimes lean eastward.

The picture of the elm tree on this page shows clearly which way the wind blows most often. The dandelion with some of its fruits blown away (page 25) shows a similar wind effect. Is the prevailing wind in these pictures from the left or from the right?

Both pictures were taken in New York State where the prevailing wind is from the west. Which direction was the camera facing for both pictures? Perhaps you can find other plants around your school or home which show uneven growth or lean due to wind.

Different kinds of trees are affected differently by the prevailing wind. Two different shapes of trees are shown in the diagram on this page. In "A" most of the crown is high above the ground where the wind is stronger and can affect it more. Most of the crown of tree "B" is near the ground where the wind velocity is lower. To which of these two types does the American Elm belong? Which type would the Norway Spruce be?

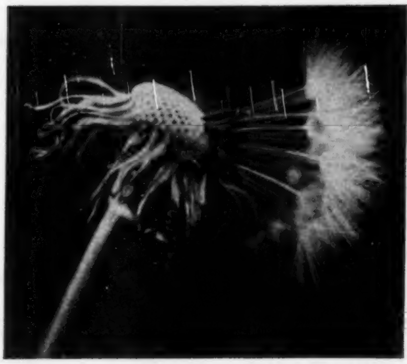



**Will tree "A" or "B" be more affected by the wind?**

Can you think of some other trees which are shaped like tree "A"? Like tree "B"?

If you know the direction of the prevailing wind, the tops of the tallest trees in a woods may be a sort of compass for you. In the woods around Brockport the tops of the pine trees all point toward the northeast. Prevailing southwesterly winds, while the pines were growing, forced the branches to bend in the opposite direction. Use a compass to tell the direction of the lean or uneven growth of trees around your school or home. Can you then determine the prevailing wind direction in your part of the State?

Wind deposits more snow on the lee side of snow fences, stone walls, buildings, and tree trunks than it does on the windward



**Wind from the west carried dandelion fruits with it.**

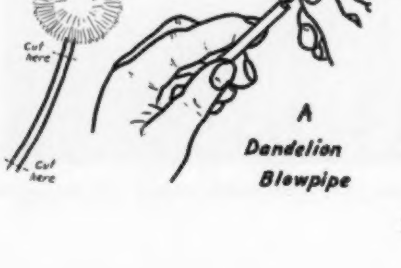
side. When it melts, this snow provides more moisture for the soil on the lee side. The wind also drops more air-borne seeds on the lee side of objects than on the windward side. These seeds are better able to germinate where they have both moisture and protection from the wind.

**In the woods around Brockport, the tops of the pine trees point toward the northeast**



## The Wind and Living Things

The wind scatters the seeds of many plants. It can carry seeds such as those of milkweed, cottonwood, and dandelion great distances. It can transport the "keys" of maples and the winged seeds of pines and other cone-bearers several feet from where they grew. In the spring use a dandelion blowpipe like that shown below to study how seeds are scattered by the wind. In the tube place a single dandelion fruit, seed end first. Poke the fruit into the tube so that the "parachute" does not stick out. Now blow the fruit into the air by blowing into the tube. Watch it float down like a parachute. Does the "parachute" of a dandelion fruit or the wing of a maple "key" really carry the seed or just make it drop to the ground slowly as the wind carries it along?

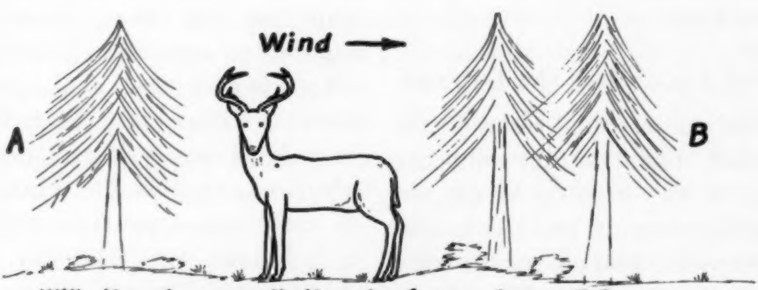



Animals use the wind in many ways. Migrating birds often take advantage of winds to cover great distances in their migration flights. Birds flying against strong

winds often fly close to the ground where the wind velocity is lowest. The same birds may fly much higher when they fly with the wind. Watch crows when they fly against the wind. Do they fly at a different level when they fly with the wind? When hawks soar in the wind they circle much farther down-wind than they do up-wind. When birds alight on the ground do they face toward the wind or away from it? Can you list some other ways in which birds use the wind?

Odors or scents carried by breezes can be detected by animals with sensitive noses. For this reason hunters stalk animals from a down-wind direction ("B" in the diagram on this page) to keep the animals from smelling them. The animals, in turn, often circle down-wind from their pursuers. Probably they can tell by sniffing the air where their pursuers are. When animals lift their noses to sniff the air, they are testing the odors which the wind brings to them from things up-wind.

You can try a simple experiment to see how animals react to smells carried by the wind. On a warm fall day open two screened windows on opposite sides of your schoolroom or a room at home. Try to choose windows where a breeze blows from one to the other. About half-way between the windows place a jar containing some vinegar, some over-ripe banana, or some soft grapes. Fruit flies like all three of these foods and will fly toward them if they can "smell" them. After the breeze has blown in one window, across the jar, and out the other window for some time, examine the two window screens. At which window can you find more fruit flies? Is the smell from the food blowing in or out of this window? Do the flies come up-wind to the jar or down-wind to the jar? Can *you* notice certain odors when the wind is from one direction, but not when it is from any other direction?



*Will the deer smell the air from A or B?*

Wind velocity is greatly affected by the type and amount of cover over which it blows. A flat field has little effect on the wind velocity, but a woods slows the wind. A simple experiment will show how the wind velocity changes near the ground. On a windy day stand facing the wind in a weedy or brushy field. Notice how hard the wind blows against your face. Now kneel on the ground. Does the wind blow as hard on your face? Now lie down on the ground. What has happened to the wind velocity? You can check your observations with your anemometer, holding it first at your eye-level, then waist-high, and finally at ground level. Where is the wind velocity highest? Where is it lowest?

Would an animal find more protection from the wind beside a barbed wire fence or beside a rail fence? Would an animal find more protection from the wind on the ground, in a low tree, or in the top of a tall tree? Why do most animals prefer hedgerows to open fields?

### Wind Far Above the Ground

You can *feel* the wind near the ground, but you can only *see* what it does high up in the air. You can see gulls and hawks soar in the wind. You can see the wind carry clouds along. The clouds move as fast as the wind. Sometimes you can see the shadows of clouds race across roads and fields. Can you run as fast as the shadows move? Do you think a dog or a car could catch the shadows? How fast do you think the clouds are going to make shadows travel so fast?

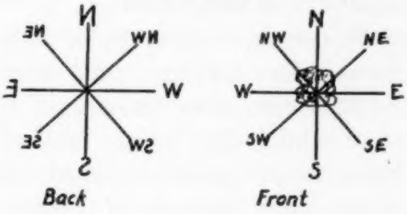
You can learn the *direction* in which the clouds move with a *nephoscope*. One kind of a nephoscope consists of a horizontal mirror with directions marked on it. You can make a simple nephoscope of this type. On the back of a small mirror – one from a discarded purse will do – scratch four broad straight lines which cross to form a pattern like that shown in the diagram on page 29. The lines should be 2 or 3 inches long. Label the lines as shown. If you make the letters backwards on the back of the mirror, they will look right when you turn the mirror over. Now lay the mirror, shiny side up, so that the "N" points toward the north. A window sill is a good place to put it. With one eye closed, move the nephoscope until you can see the reflection of a cloud at the point where the lines cross. Then hold your head very still and decide which of the lines the reflection of the cloud appears to follow. If it follows the "NE" line, the clouds are travelling northeast. If

it follows the "W" line, the clouds are travelling west, and so on. It is not possible to tell how fast the clouds are moving but merely the direction of the movement. Which would seem to go faster in your nephoscope — a high cloud or a low one?

Prevailing winds and those at high altitudes are important to airplane pilots. An airplane flying from Buffalo to Albany would go faster in a west wind (tail-wind) than in an east wind (head-wind). Across the north Atlantic Ocean the prevailing winds are westerly, while near the equator they are easterly. Which route (northern or equatorial) would an airplane pilot probably choose if he wanted to make a fast flight from New York City to England? Which route would probably mean a faster trip from England to New York? Why? Are most of the United States airplane records made when flying east or when flying west? Why?

You can try an experiment to see which way the winds blow high in the air. You will need some thread, two or three postal cards, and a circus balloon or any gas-filled balloon which will rise when you let go of it. The science teacher in your school may be able to fill balloons for you. Punch a small hole near one edge of the postal cards and tie them

*Nephoscope*




*Lay the mirror flat with the "N" north. Find a cloud's reflection where the lines cross and watch what direction it moves.*

with thread to the neck of the balloon. The thread should be long enough to allow the cards to dangle a foot or two below the balloon. Tie on as many cards as the balloon will lift easily. Now address the cards in pencil to yourself. On the back of the cards ask whoever finds them to tell where he found them and to mail them at once. You can let your balloon go up in the air now. A windy day is better than a calm day for this experiment.

As your balloon rises through the "air sea" above you, the air gets shallower and shallower. There is less and less air pressure outside the balloon, but inside the balloon there is just as much gas as there was when you released it. This makes the balloon expand as it rises. The balloon keeps stretching until somewhere high in the air it cannot stretch any more so it bursts. Down will come your postal cards, all ad-

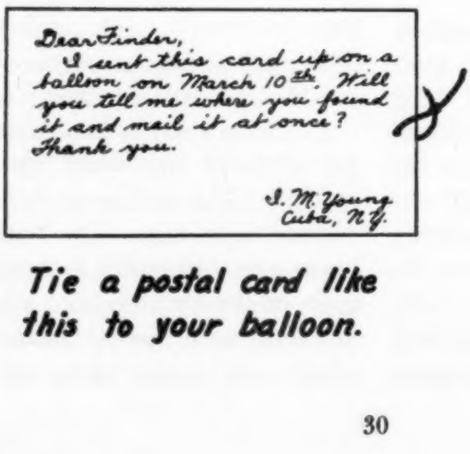
dressed and with a message for anyone who finds them.

Of course, it may be a long time before anyone finds your cards, so you must be patient. If your whole class sends up balloons with cards attached to them, your chance of getting some cards back will be better. Maybe you can arrange a small prize for the person whose cards go the farthest, or for the one who receives the first returned card. Do you think your cards will be found east or west of where they were released? Perhaps you can try this on a day when there is an east wind, and again on a day when there is a west wind. Label your cards so that you know which cards were sent up on which day.

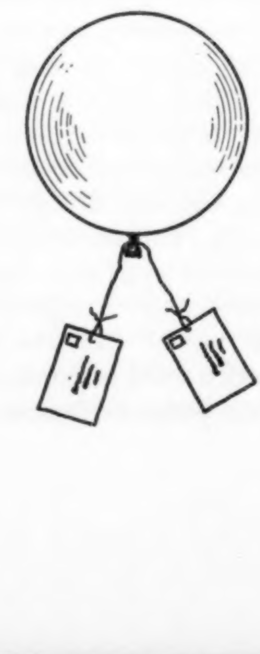
### Air and Sound

Wind helps or hinders sounds much as it does scents. When the wind is blowing, you can call to a person down-wind much more easily than you can to a person up-wind. Sound travels faster and louder with the wind than it does against the wind. When the air is full of fog droplets or snow, sound does not travel well. The whistles, sirens, or horns that tell the hour in towns and in factories are fainter during a fog or a snowstorm than when it is clear. Do the sounds seem clear or muffled on a foggy or a snowy day? Is light, too, fainter and less clear in fog and snow? Does rain affect sound as fog and snow do?

If you listen carefully, you can distinguish many different sounds which the wind produces as it blows through and around things. It often makes telephone wires hum. It makes a soft "whishing" sound as it blows through pine trees. Does it make a similar sound as it blows through




*Tie a postal card like this to your balloon.*



screens? Can you tell the difference between the two sounds? The wind makes one sound when it blows through leafless maples and another when the leaves are on the trees. Aspen leaves trembling in the breeze sometimes sound like a light rain falling. Shutters may rattle in the wind, or a barn door may creak. Guy wires on windmills or television antennae have their own wind sounds. The corners of eaves, gutters, doors, and windows all add their sounds to others in the wind's chorus.

Perhaps you can make a list of the different sounds which you hear the wind cause. Can you describe each of them in words? Do they change as the wind velocity changes? You can use some of these sounds to tell how fast the wind is blowing. A wind that is just strong enough to make the aspen leaves tremble is not strong enough to sigh in the pines. A wind that swishes through the screens on the porch may not be strong enough to whistle and moan around the eaves. Could you make some sort of "listening scale" to tell you about how fast the wind is blowing? When you have become accustomed to listening for wind sounds, you will be able to tell quite accurately how fast the wind is blowing by the type of sounds it causes. And you can have fun listening to the wind "talk" to you as you walk through the fields and woods and to and from school.

If you have enjoyed using this Leaflet in your "air laboratory", you will want to go on with other studies. You can do many interesting things by yourself or with the help of your teacher and your textbooks or references such as those listed on page 32.

You know that wind can do work. Make some kites or gliders or sailboats, and see how you can use the wind to make them move. Watch how wind helps wet clothes to dry faster. Learn as much as you can about how airplanes use air and wind. Look for ways in which wind is a help, and for ways in which it causes damage.

With what you know about air, you are ready to go on with the fascinating study of "What will the weather be?" You can learn much by yourself. Keeping records of pressure, temperature, relative humidity, wind, and weather may give you clues to tomorrow's weather. Does one particular wind direction usually precede rainy weather? Does the pressure usually rise or fall just before "bad" weather? What happens just before "good" weather?

Study the weather maps for the United States if you can get them.

Many daily newspapers print them, and your teacher and your textbooks or other books will help you learn to use them. Listen to the reports on weather across New York State given over your local radio station. With your own instruments and records and the other helps, you can learn to make surprisingly accurate forecasts of tomorrow's weather. Perhaps you would like another Leaflet to help.

### Some Useful Books

**The Wind and Peter.** By Alvin Tresselt. Oxford University Press, New York. 1948. 32 pages. Attractive for small children.

**The Air About Us** (1941, 36 pages); **Clouds, Rain and Snow** (1941, 36 pages); **Thermometers, Heat and Cold** (1942, 36 pages). By Bertha M. Parker. Row, Peterson and Company, Evanston, Illinois. Well-illustrated booklets for grades 4 to 6.

**Between Earth and Sky.** By Marion MacNeil. Oxford University Press, New York. 1944. 62 pages. A simple account of climate, weather, and weather instruments for grades 4 to 6.

**Everybody's Weather.** By Joseph Gaer. J. B. Lippincott Company, Philadelphia. 1944. 96 pages. Well-illustrated with photographs. Grade 5 and above.

**Everyday Weather and How It Works.** Herman Schneider. Whittlesey House, McGraw-Hill Book Company, New York. 1951. 181 pages. A well-illustrated helpful book. Grade 5 and above.

**Weathercraft, How to Make and Operate Your Own Weather Station.** By Athelstan Spilhaus. Viking Press, New York. 1951. 64 pages. Directions for making and using simple weather instruments. Grade 5 and above.

**Weather.** By Gayle Pickwell. Whittlesey House, McGraw-Hill Book Company, New York. 1938. 168 pages. Large beautifully illustrated book. Grade 7 and up.

**Ask The Weatherman** (1941, 36 pages.); **Our Ocean of Air** (1941, 36 pages); **The Ways of The Weather** (1941, 36 pages). By Bertha M. Parker. Row, Peterson and Company, Evanston, Illinois. Well-illustrated booklets for teachers and older students.

**The Climate of New York State.** By R. A. Mordoff. Cornell Extension Bulletin 764, December 1949. A general discussion with many useful maps and tables. For teachers and older students.

**Clouds, Air and Wind.** By Eric Sloane. The Devin-Adair Company, New York City. 1941. 80 pages. Large attractive book with helpful illustrations and cartoon-like diagrams. For older readers.

**What Is This Thing Called Humidity; Instructions for Home Weather Forecasting.** Taylor Instrument Companies, Rochester, New York. Two helpful folders for teachers and older students.